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QUARTERLY PROGRESS REPORT, JULY 1-SEPTEMBER 30, 1970

Federal Water Pollution Control Administration
Corvallis, Oregon

October 1970

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QUARTERLY PROGRESS REPORT

PACIFIC NORTHWEST WATER LABORATORY CORVALLIS, OREGON

JULY 1--SEPTEMBER 30, 1970

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FEDERAL WATER POLLUTION
CONTROL ADMINISTRATION
NORTHWEST REGION

CLEAN WATER

45

PACIFIC NORTHWEST WATER LABORATORY

QUARTERLY REPORT

July 1 through September 30, 1970

United States Department of the Interior
Federal Water Quality Administration
Northwest Region, Corvallis, Oregon

October 1970

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NATIONAL THERMAL POLLUTION RESEARCH PROGRAM

PPB 1613

Status of Projects and Significant Accomplishments

Work Plan ZFL: Consultation and Advisory Services

At the initial request of the Assistant Secretary's Office the NTPRP staff conducted a comprehensive analysis of the technical and economical feasibility of various closed cycle cooling systems for thermal electric generating stations in the vicinity of Lake Michigan. This work was done in cooperation with the Great Lakes Region and culminated in the preparation of a report entitled "Feasibility of Alternative Means of Cooling for Thermal Power Plants Near Lake Michigan." In addition, a supplement to the report applicable to nuclear power plants was prepared.

At the request of the Assistant Commissioner for Enforcement and Standards Compliance the report was presented at the Lake Michigan Enforcement Conference Workshop Session, Chicago, Illinois. Dr. Tichenor formally presented the report September 28, 1970.

Work Plan ZFD: Heat Transport and Behavior in Large Hydrologic Systems

A study to determine the effect of thermal discharges at various levels in a stratified lake was completed by Cornell Aeronautical Laboratory. Using mathematical models and associated computer programs, it was found that thermal discharges at or below the thermocline will increase the length of the stratification

period as well as the temperature of the epilimnion. Also, the effect of the pumping alone (i.e., the discharge of water at the ambient temperature) was shown to increase the volume and decrease the average temperature of the thermocline.

An experimental study on the mixing between a warm water wedge and the underlying cool water was conducted by Cornell Aeronautical Laboratory. This study showed that the transfer of heat across the stable interface was inhibited to a much higher degree than the transfer of momentum. In the course of preparing the experimental apparatus, techniques for measuring very small flow velocities (e.g., 0.1 cm/sec) were perfected.

The stochastic model development cooperative project with FWQA's Systems Analysis and Economics Branch, Headquarters, and the refinement of techniques for predicting stream evaporation continue.

The research by Cornell Aeronautical Laboratory on the Physical Aspects of Thermal Pollution 14-12-526 was completed; formal approval is pending receipt of revised final report.

Work Plan ZFC: Heat Transfer and Behavior in the Mixing Zone

A final report has issued from the research by Tetra Tech, 16130 DWQ, on "Studies on the Effect of Waste Heat Discharged from Nuclear Power Plants into Large Bodies of Receiving Water." Some of the conclusions reached are as follows:

1. Initial mixing for subsurface discharge

The flow field resulting from a row of equally spaced round buoyant jets discharging at an arbitrary angle into a quiescent

ambient with arbitrary density and temperature stratification is formulated. A computer program has been written to obtain the solution given the jet characteristics and the ambient conditions. The flow field consists of two zones. Near the source, the individual round jets behave as if they were single jets. Further away, they merge together and resemble a two-dimensional slot jet. The transition from one zone to the other is taken to be either when the round jet is equal to the jet spacing or when the entrainments based on round jet analysis and slot analysis are equal. Due to the relatively large dilution ratios and the fact that the temperature excess of the discharge is usually only 10 to 20°F, a very small density stratification is sufficient to prevent the discharge from reaching the surface. In that event, all the temperature excess is simulated in the ambient top surface water.

2. Intermediate phase for subsurface discharge.

In the event the buoyant jet reaches the free surface, a model is developed to obtain the spreading of the buoyant fluid on the ambient.

3. Subsurface horizontal buoyant jet.

The flow field induced and the dispersion process in the horizontal buoyant jet discharge at the surface was investigated. The interplay of source momentum, source buoyancy, interfacial shear, entrainment, and surface heat loss have all been incorporated in the model. The two-dimensional case has been treated in detail. The flow field is found to possess features different from that of

either an ordinary non-buoyant jet or a fully submerged buoyant jet. The type of flow field is found to depend on the relative magnitudes of the free parameter, the Froude number, the heat exchange coefficient, and the source Reynolds number. The findings have application in design considerations since: (a) the temperature distribution is dependent on the type of flow field and (b) inundation of the source may lead to short-circuiting the intake and discharge of cooling water.

4. Passive diffusion in a current.

Two mathematical models have been developed resulting in two computer programs, PTD and UTD. In both models, longitudinal dispersion is ignored, lateral dispersion is assumed to follow a four-third power law, and the vertical diffusion coefficient is allowed to be an arbitrary function of the vertical coordinates. Program PTD treats the case of steady release of contaminant into a steady unidirectional shear current. Program UTD treats the case of a time variable release into a time varying uniform current. The surface heat exchange coefficient assumed constant in PTD is allowed to be time varying in UTD. Results from the model are as would be expected. Larger diffusion coefficients result in larger dispersion. The presence of current shear was found to enhance the dispersion process.

In the "Thermal Plume Dispersion" study by Oregon State University, 16130 DGM, the transition region in the vertical buoyant jet has been treated in a two-dimensional axisymmetric case. Results

to date are mainly concerned with verification of the computational procedure and computer program. Verification is accomplished by checking numerical computations against experimental data and similarity solutions for deep water case, that is, negligible surface effect. Comparisons are made for axial center line and lateral velocity and temperature of concentration distribution. Thus far a number of check cases have been run for the axisymmetric case which include both buoyancy coupled and an uncoupled hydrodynamics. These cases include comparison of results between radial eddy-transport coefficients, determined from mixing length theory and those which remain constant. Vertical eddy transport, although included in the computation, is set at a negligibly small value. Ambient density stratification has not been dealt with in the verification effort but will be investigated at a later date. Verification has not been carried out for the line plume case at this time.

Besides the grant 16130 DGM with Oregon State University the following are also active and continuing:

a. "Project for Concentrated Research and Training in the Hydrologic and Hydraulic Aspects of Water Pollution Control," Vanderbilt University, 16130 FDQ, Project 1 - Temperature Distribution Resulting from Cooling Water Discharges.

b. "Prediction and Control of Thermal Pollution," MIT, 16130 DJU (also, see Work Plan ZFH).

There is also an in-house cooperative project with USGS on the subject of "Turbulent Diffusion of a Heated Plume."

Work Plan ZFF: Engineering and Cost Aspects of Heat Dissipation

In a draft of a final report from R. W. Beck and Associates on "Non-evaporative Cooling Tower," information was presented on the theory of dry cooling towers as it would apply to steam and electric generating plants. Operating results were summarized for several existing dry cooling tower installations. The comments of various equipment manufacturers and suppliers were summarized and the results of economic analyses made for dry cooling systems were presented for an 800-megawatt generating unit for 27 representative sites in the United States. These reflect a range of fixed charges, fuel costs and weather conditions.

An engineering-economic study of cooling pond performance was completed by Littleton Research and Engineering Corporation. Analytical methods for predicting pond performance were developed for both flow-through and well mixed ponds. Various vertical velocity profiles were considered. Temperatures from five existing cooling ponds were compared to predicted values. The cost of cooling ponds, in dollars per year, for various land costs and condenser temperature rises were computed for a hypothetical 2000 MWe power plant near Philadelphia, Pennsylvania. Various pond sizes were evaluated, and cost comparisons with wet natural draft cooling towers were made. Methods of computing evaporative water losses from cooling ponds were also developed.

The following extramural research continued:

1. Dynatech Corporation, "Survey and Economic Aspects of Alternate Cooling Methods for Cooling Condenser Discharge Water in Thermal Power Plants."

2. Purdue University, "Turbulent Bed Cooling Towers."

3. Travelers Research Corporation, "Study of Costs of Reducing Heat Disposal to Aquatic Environment by Steam Electric Power Plant."

4. United Aircraft Corporation, "Feasibility of Non-thermal Power Generation Systems."

Work Plan ZFJ: Beneficial Use of Waste Heat

Dr. Garton presented a paper on "Beneficial Uses of Waste Heat--An Evaluation" at the Conference on Beneficial Uses of Thermal Discharges, Albany, New York, September 18, 1970. Preparation of this paper by Garton and Christianson involved a thorough review and a practical evaluation of current prospects and potential problems in waste heat use. The paper is considered a useful current status report for project evaluations and future planning.

NATIONAL COASTAL POLLUTION RESEARCH PROGRAM

PPB 1607

Status of Projects and Significant Accomplishments

Ocean Outfalls

Work continues on "Ocean Outfall Design, Part II: Recommended Practice and Guidelines for Monitoring." This report includes information on the necessary oceanographic and engineering studies prior to design, a discussion and recommendation of alternative models used for design, and methods recommended for use in setting up surveillance programs to monitor the water quality which results from the discharge of partially treated wastes to the marine environment.

Barge Disposal Systems

The state-of-the-art report, previously prepared in rough form, is being corrected and redrafted. In addition, we are working out several examples of waste discharge situations and the resulting distribution of pollutant material, both the dissolved liquid fraction and the particulate material which undergoes several regimes of distribution as it is affected by the ocean environment. We have chosen to work on domestic sewage sludge because it is expected to have the most similarities; work is expected to be done on important industrial sludges and concentrated wastes via grants. See "Trace Elements" (p.10) for trace materials inputs from municipal wastes.

Estuarine Modeling

1. Columbia River Estuary Temperature Model: The first draft of Part II, "Input-Output and Preliminary Verification," of the Columbia River model report was completed, and is currently under review.

2. State-of-the-art Report: The final report by Tracor has been completed; it will be forwarded to headquarters in early November for publication by the Project Reports System. A chapter prepared by a staff member was included in the report as a "discussion and alternate viewpoint."

NTA

A simulated estuarine system in operation at our lab facility in Newport uses water collected from Yaquina Bay at high tides. Sediment from Yaquina Bay is prepared and deposited in the estuarine simulator, and runs made at two levels of NTA in the test chamber of the system. Analyses for NTA are made in the liquid and the sediment of the first and third sections of each chamber in order to determine, in crude fashion, how long the NTA might persist in the environment and if any is incorporated directly in sediments. Analyses are also made of tract metal ions, as well as pertinent anions, etc., in both sediment and liquid. In these experiments we wish to determine if the NTA influences the mobiliation or distribution of elements which may be beneficial or deleterious to marine organisms. Progress was hampered until recently by the inability to analyze for NTA in seawater.

A procedure, satisfactory for following large concentrations (5-10 mg/l) of NTA, was obtained from Canadian sources and has been applied to this work with a rather insensitive polarographic instrument. A much more sensitive machine is being procured. No attempt has been made as yet to utilize tracer techniques for establishing the compartmentalization of NTA, pending legal arrangements for such tracer work. Research is also conducted on the rate of oxidation of NTA in seawater using the Warburg respirometer and conventional long-term BOD's, using Yaquina Bay and Puget Sound seawater and three different seeds.

Trace Elements

A request for facilities usage at the Radiation Center, Oregon State University, is in progress in the University's administrative organization. The Space Allocation Committee has granted us the use of a suitable laboratory, which has been occupied, and our elaborate pulse height analysis equipment has been deployed and connected. One or two items remain to be procured, but the system is now usable. It is intended eventually to establish a direct OSU computer input from this equipment. However, the Radiation Safety Committee has not yet granted permission to carry on actual radioactivity work. While they approved our workplans and proposed radiation usage, they have raised two questions: (a) does AEC relinquish its responsibilities in this matter (since we are a Federal laboratory), and (b) has the university's legal protection been adequately ensured by a contractual agreement with the PNWL. These legal and administrative matters are being

pursued. It now appears that item (b) will have to be submitted to the Oregon Board of Higher Education. The AEC answered question (a) with a letter of declination.

A working paper (#78) entitled, "Trace Materials in Wastes Disposed to Coastal Waters," was received from the printer and will be distributed to Regional Directors, Assistant Commissioners, and a limited number to interested parties.

Consulting Services

1. In July the Program Chief testified at the court trial of the State of Minnesota vs. Reserve Mining Company.

2. At the request of Headquarters FWQA, a review of Hawaii trust territory research areas was provided, including a workplan for research on small Pacific islands.

3. Review comments were provided the Director, Water Quality Standards, on the Lake Michigan White Paper on the formulation of temperature standards.

4. Chief, Physical Oceanography, participated in the Lake Michigan thermal pollution workshop held in Chicago.

5. In answer to a request from the Director, Division of Process Research and Development, a review and possible plan of action were made on the subject of sampling submerged ocean outfalls.

6. Chief, Chemical and Biological Oceanography, prepared a review of "coastal eutrophication problems" for the PNWL Director.

7. A project representative attended a meeting of the Biological Methods Committee and has been contributing the marine point of view to an essentially freshwater manual.

8. Program chief consulted with Southwest Regional Office regarding exceptions to the Commissioner's proposed construction grant policy of 85 percent BOD removal for discharges to "open ocean waters." A suggested method for determining "open ocean waters" was included.

An estimated 30 percent of the program time, manpower, and funds are expended on technical consultation, although no workplan provides for this service. A workplan, ZAR, entitled "Technical Consultation on Coastal Pollution Problems," was submitted to headquarters, to include such items as completion of the Columbia River estuary temperature model, analysis of temperature distribution in Lake Michigan, analysis of taconite distribution in Lake Superior from Reserve Mining Company, analysis of present and proposed discharges in and around San Francisco Bay regarding the Commissioner's proposed policy on construction grants, Lakes Superior and Michigan enforcement support, and unplanned resources to cover items which occur with great frequency in the conduct of the program's planned research.

Equipment and Instrumentation

A Hewlett-Packard Calculator Model 9100B was received.

Bids were received, evaluated, selected, and returned to headquarters on the electronic particle counter to be used in the studies on the fate of solids.

Grant and Contract Research

Grant and Contract Applications

The following subjects of grant and contract proposals and preproposals were reviewed by program staff during the quarter:

1. Ocean Disposal on the Continental Slope, continuation, 16070 EOI.

2. Interrelationships of Municipal Wastes and Red Tide Outbreaks, 16080 FIL.

3. Tidal Variations of Water Quality Parameters in Estuaries: Longitudinal and Vertical Distributions, 16070 GIN.

4. Eutrophication in Coastal Waters, 16070 GDA.

5. Control of Nitrate and Phosphate Pollution in the Marine Environment, 16070 GBA.

6. Investigation of Saltwater Pollution in Freshwater Aquifers by Electromagnetic Methods, 16060 GIS.

7. Development of Mathematical Model for Fate of Pollution in Nearshore Waters, 16050 FYQ.

8. Effects of Pollutants on Some Planktonic and Benthic Microorganisms in Coastal Waters of Southern Puerto Rico, and The Effect of Organic Pollution in Sea Water on the Biological Availability of Calcium - preproposals.

Reports and Papers

1. Baumgartner, D.J., M.H. Feldman, L.C. Bentsen, and T.L. Cooper, "Field Studies in Yaquina River Estuary of Surface Gas Transfer Rates," presented at FWQA Georgia Institute of Technology Symposium and Demonstration, "Direct Tracer Measurements of Reaeration Capacity of Streams and Estuaries," July 7-8, 1970.

2. Feldman, M.H., "Trace Materials in Wastes Disposed to Coastal Waters: Fates, Mechanisms, and Ecological Guidance and Control," FWQA Northwest Region Working Paper #78, July 1970.

3. Callaway, R.J., and K.V. Byram, "Computed Flow Reversal in the Lower Columbia River." submitted to Limnology and Oceanography, August 1970.

Plans for Second Quarter, FY 1971

A more efficient division of labor and resources was suggested in the form of revised workplans for the fiscal year, concentrating on areas in which most of the program's competence lies, and deleting areas which realistically cannot be accomplished with current budget and manpower limitations. If approved, in-house research in the next quarter would include studies on barge dump disposal of wastes in ocean and coastal waters, estuarine and ocean outfalls, fate of NTA in coastal waters, and technical consultation on coastal pollution problems.

Ocean Outfalls

Work will continue on "Ocean Outfall Design: Part II." As part of this effort a more detailed report will be started describing the operation of the mathematical models used for design and analysis of monitoring data, including input-output instructions, and a number of calculations of typical situations. Another report will be started, to be published in a technical journal, describing the theoretical development and verification procedures used for a more comprehensive mathematical model of outfall analysis than has been heretofore available.

Barge Disposal Systems

Studies in support of the barge dump disposal of wastes workplan will begin in Puget Sound.

NTA

In future work we will add elements or increase the quantities of those presently found naturally to see if these influence the rate at which NTA is metabolized. Future plans include addition of various metal salts to determine their influence on NTA degradation.

Estuarine Modeling

Part II of the Columbia River model report will be reviewed and prepared for publication.

The state-of-the-art report on estuary modeling will be printed and distributed. A report on the results of the study will be presented to the FAO meeting in Rome.

Trace Materials

Staff members will continue to set up our analysis capability at the neutron activation facility of Oregon State University, and Chief, Chemical and Biological Oceanography, will work on developing a grant for work on trace organic compounds in domestic sewage sludges, which requires a competence different from that we now possess in the program.

NATIONAL EUTROPHICATION RESEARCH PROGRAM

PPB 1601

Status of Projects and Significant Accomplishments

Work Plan CNC: Comprehensive Investigations to Evaluate Influence of NTA on Environment

Laboratory and *in situ* algal assays were conducted on waters from, and in, lakes in Oregon representing three trophic levels; oligotrophic (Waldo Lake), mesotrophic (Triangle Lake), and eutrophic (Cline's Pond). Water samples from these lakes were collected for laboratory assays concurrently with conducting ^{14}C *in situ* assays in the lakes. At Shagawa Lake, Minnesota a series of *in situ* assays were made in 80-gallon plastic bags containing either Shagawa Lake water or Burntside River water. In both the laboratory and *in situ* assays a series of additions were made to the waters including NTA, carbon, nitrogen, secondary and tertiary treated sewage effluents, and secondary and tertiary treated sewage effluents resulting from primary settled sewage containing NTA. The fate of NTA was also followed in large experimental pools placed in Cline's Pond.

Studies were initiated with metal-containing sediments to determine whether metals deposited in sediments can be solubilized by NTA. A polarographic method for analysis of NTA in freshwater, seawater, sediments and sediment-water systems has also been under investigation. Each of these areas of study is described more specifically below.

1. *In situ* ^{14}C assays -- Na $^{14}CO_3$ and the various additions mentioned above were added to 125 ml stoppered flasks containing the lake water and suspended in the lakes at depths of optimum light intensity for periods of two to four hours. Rates of uptake of ^{14}C by the indigenous algae served as indication of the effects of the various additions upon primary productivity in the lakes. Eleven such experiments have been completed. While the data have not been completely analyzed some preliminary observations can be made.

Generally the addition of NTA to the natural waters had little or no effect in these short-term experiments. In only 2 of 11 cases, both of these in mesotrophic waters, was there a stimulation of ^{14}C-fixation. Secondary sewage effluent, on the other hand, generally stimulated primary productivity.

2. Laboratory Assays — All assays were conducted in 500 ml Erlenmeyer flasks containing 250 ml of sample, incubated for 21 days at 24°C under continuous fluorescent lighting of 400 ft-c and shaken continuously at 110 oscillations per minute. The same additions were made to the natural waters in these experiments as in the *in situ* studies. In one series of assays the water samples were filtered through an 0.45μ membrane filter, the additions made, and inoculated with the green unicellular alga, *Selenastrum capricornutum*.

Algal growth was followed by cell counts, fluorescence (Chlorophyll a) measurements and dry weight determinations. In another series of assays the additions were made to unfiltered water samples

and growth of the indigenous algal population followed by fluorescence and dry weight determinations.

While the data have not been completely analyzed they indicate that NTA generally stimulates algal growth. Based upon chemical analysis to date, NTA does not appear to degrade significantly in the natural waters studied during the 21-day incubation period. The stimulation of algal growth by NTA, therefore, does not appear to be related to NTA degradation, but may be related to the chelating properties of NTA and algal trace metal metabolism. Both secondary sewage effluent and secondary sewage effluent resulting from primary sewage containing NTA generally stimulated algal growth. Chemical analysis, however, indicates that the latter contained more NH_3-N than the former. The addition of either carbon or nitrogen to the natural water samples had no apparent effect on algal growth.

3. Shagawa Lake Studies — Neither NTA, nitrogen nor phosphorus stimulated algal growth in Burntside River water over a three week period, when added singly. However, nitrogen plus phosphorus always resulted in significant growth stimulation. The addition of NTA plus P resulted in increased algal growth following a lag period of 10 to 14 days. Secondary sewage effluent always appreciably stimulated increases in algae populations. Stimulation by secondary effluent obtained from primary effluent containing NTA was appreciably greater than that from the regular secondary effluent.

Addition of NTA or N, singly, resulted in algal growth stimulation part of the time in Shagawa Lake water. As was the case with Burntside River water, stimulation by NTA occurred following a lag period. NTA or N plus P always resulted in appreciable algal growth stimulation with the NTA plus P combination showing a 4- to 11-day lag. Addition of P alone resulted in increased growth part of the time. Secondary effluent always stimulated growth; that derived from primary effluent containing NTA was more stimulatory than that derived from NTA-free primary effluent.

4. Cline's Pond Studies — NTA added to an experimental pool at a concentration of 4.5 mg/l at the surface was completely degraded within 60 days. Degradation occurred as rapidly in a low oxygen (0.5 to 3.0 mg O_2/l) zone as in a high oxygen (5.5 to 10.5 mg O_2/l) zone. Data from this single experiment tend to show that algal growth was enhanced by the addition of NTA as compared with a control pool in the pond.

5. Analytical Methods — The polarographic method has proved to be satisfactory for NTA determination and is the only method found which is applicable to sea water.

Two polarographic methods were evaluated. These methods, originally proposed by Dr. Goulden of Canada, involve complexation of the NTA with lead or bismuth and polarographic determination of the complex.

The procedure utilizing bismuth offers several advantages over the method measuring the lead-NTA complex. It is simpler, can

be used to measure NTA in sea water, and is carried out at a pH of two rather than eight. The method exhibits good reproducibility over the range of 1 to 4 mg NTA/l (0.05 to 0.2 mg NTA in 50 ml of solution) using a Sargent XV polarograph. The usual concentrations of calcium and magnesium found in water do not interfere with the Bi-NTA method. Large concentrations of iron and copper interfere.

The polarographic method and Zinc-Zincon method utilizing a Technicon gave comparable results for NTA in natural water samples over the range of 1 to 5 mg NTA/l.

6. Sediment-NTA Interaction Studies — Lake sediments containing copper, arsenic, and mercury are being received from California, Wisconsin, and Michigan for experimental studies to determine whether such metals deposited in sediments can be solubilized by NTA. At present experiments are underway on copper-containing sediments from Clear Lake, California, utilizing both aerobic and anaerobic environments.

Work Plan ZCB: Assay Procedures for Determining Productivity Responses

Most of the research activity during this quarter was devoted to the use of the "Bottle Test" and "*In situ* Test" of the Provisional Algal Assay Procedure (PAAP) to evaluate the effects of NTA on algal growth and primary productivity. The data obtained from these investigations will, in part, serve as a basis for determining the capabilities of the two types of assays and as a comparison of test performance - one with the other.

This laboratory, along with seven other laboratories, participated in an inter-laboratory precision test to evaluate the PAAP "Bottle Test." All laboratories used exactly the same methods for sample preparation and preparation of inocula, used reagent chemicals from a common source, incubated the test flask under the same conditions and measured growth responses in a like manner. The data obtained were all sent to Professor Weiss at the University of North Carolina for analysis. The results will be reported at an October meeting of all participants.

Work Plan CND: Lake Restoration Techniques

In continuation of the monitoring program established for Waldo Lake in 1969, limnological sampling was conducted monthly during the quarter. Studies to determine groundwater movements in the vicinity of a campground comfort station septic tank continued through the quarter. Dye studies show that septic tank wastes have migrated below the shoreline of the lake, but have not yet discharged into the lake. This is caused by the water table not being sufficiently elevated to reach the lake surface. Further study next spring will be necessary to determine if aquifer recharge at that time will overcome this situation.

The Albany, Oregon lakes were sampled in July as part of a continuing program to characterize them and assess their potential as experimental lake restoration sites.

Aquatic macrophytes were sampled from several ponds south of Corvallis in continuing studies of nutrient uptake by these plants.

Studies were carried out at Shagawa Lake to evaluate the effect of container size in *in situ* assay experiments. Shagawa Lake water containing added N and P was used to fill basins of 8-, 80-, and 150,000-gallon capacities. Algal growth was followed for a period of three weeks to obtain data on the relative validity of assays performed in isolated environments of greatly different size scales. The data obtained are now being analyzed.

The Shagawa Lake project was visited by Messrs. Gahler and Sanville from the PNWL to initiate a bottom sediment mapping program for the lake and to obtain sediment samples for Battelle-Northwest relating to contract research.

Considerable time and effort were devoted to planning and preparation for the design of the advanced waste treatment plant at the city of Ely, Minnesota. Mr. Brice, who is in charge of the Shagawa Lake Eutrophication Control Project, has been closely involved in the planning along with AWTRP, FWQA Headquarters, the city of Ely, HUD, and several consulting engineering firms.

An experimental pool (16' x 16') in Cline's Pond was treated with aluminum sulfate (alum) in an effort to precipitate algae and nutrients. Following treatment, secchi disc measurements fluctuated between 80 and 200 cm. Transparency was almost always greater than in the pond itself and in the NTA-treated pool, but frequently less than that in the control pool. The pH of the alum-treated pool

remained lower than that in the other pools and the pond throughout the experiment. No sulfide was detected. The numbers of phytoplankton decreased in the surface waters after the alum was added, but there was little change in the phytoplankton population in the lower water. Total phosphorus at the surface was lower than that in the pond itself, but not lower than that in the control. Oxygen was consistently lower in the treated pool than in the control pool and the pond. The eventual appearance of large numbers of *Daphnia* and tadpoles indicated a lack of toxicity to these animal forms. They were also found in large quantities in the control pool and the pond.

Other Activities

Dr. Bartsch, Mr. Maloney, Dr. Powers, and Dr. Malueg met with other FWQA personnel and representatives of the Food Machinery Corporation at FWQA Headquarters early in July to discuss the relative importance of phosphorus and carbon in eutrophication. Mr. Maloney met with other members of the FWQA Biological Advisory Committee on July 28-29 in Cincinnati to discuss standardization of biological sampling methods for incorporation into a methods manual.

Publications and Presentations

"Seasonal Distribution of Phosphorus in Total, Inorganic, and Organic Fractions of Eutrophic Lake Sediments" by Wildung, Blaylock, Ralston, and Gahler. Presented at the annual meeting of the Soil Science Society of America.

"Effect of Nitrilotriacetic Acid on the Growth and Metabolism of Estuarine Phytoplankton" by Erickson, S. J., Maloney, T. E., and J. H. Gentile. JWPCF, 42, 8 (Aug. 1970).

"A Screening Technique for Estimating Copper Toxicity to Estuarine Phytoplankton" by Erickson, S. J., Lackie, W., and T. E. Maloney. JWPCF, 42, 8 (Aug. 1970).

Grant and Contract Research

Technical reviews of proposals for research and demonstration grants, and contracts were provided for the following subjects:

Potential Algal Productivity as Measured by a Turbidostat.

Effect of Phosphorus Removal Processes on Algal Growth

The role of Nitrogen and Phosphorus in Eutrophication.

Unicellular Cyanophytes-their Genetics and Viruses

Nutrient Diversion Effects on Eutrophication

Aspects of Phosphate Utilization by Blue-Green Algae

Effect of a Change in Waste Treatment on the Ecosystem of a Tidal River.

Effect of Herbicides on Fresh Water Algae

The Effect of Hydrocarbon Pollution on the Carbon Dioxide-Water System.

The Development of an *In situ* Water Sampler

Eutrophication in Coastal Waters.

Eutrophication in Coastal Waters: Nitrogen as a Controlling Factor.

Simulation of Plankton Productivity.

Chemical, Biological, and Geological Studies on Lake Ontario in Coordination with the International Field Year for the Great Lakes.

Utilization of Organic Compounds by Algae

Plans for Second Quarter, FY 1971

Experimental data obtained over the past several months relating to NTA will be composited, analyzed and a report of the findings prepared. Studies of the metal solubilizing and chelating actions of NTA in sediments will be continued.

Limnological sampling trips to Waldo Lake and the Albany lakes as well as a field trip to Upper Klamath Lake to obtain sediment samples will be made. Analysis of Shagawa Lake sediments will be continued.

The report on the Detroit Lakes, Minnesota, lysimeter study will be completed and a report on the limnological studies at Waldo Lake will be initiated. A write-up of a standard "Bottle Test" algal assay will be started. Increased emphasis will be placed on evaluation of the continuous-flow algal assay. A project will be initiated to investigate the role of sediments in the life cycles of green and blue-green algae.

NATIONAL WASTE TREATMENT RESEARCH PROGRAM

PAPER & FOREST INDUSTRIES RESEARCH -- PPB 1204, 1210, 1301

Status of Activities and Significant Accomplishments

Our cooperative work with Crown Zellerbach Corporation at Lebanon has been terminated with completion of this R&D project. The final project report is now in preparation. Crown Zellerbach has prepared, and submitted for funding, a new proposal making use of the Lebanon treatment facilities. Objectives sought will be control of fecal coliform discharges from aerated lagoon treatment facilities through treatment process modification and manipulation.

In-house bench scale work has continued on a project to determine the solids, coliform, and color reduction possibilities employing polymers and flocculants on aerated lagoon effluents in the pulp and paper industry. Work to date, operating on Halsey mill effluent, indicates high efficiency removals of color, coliform, and solids are possible on this waste, employing the synthetic polymer so far investigated. The economics of treatment are not now a consideration but will be developed after optimum treatment sequences are realized. Some preliminary examination of Lebanon effluent has begun and will be enlarged, with similar objectives in mind. Wastes from Weyerhaeuser Co. at Springfield and Western Kraft at Albany will also be examined.

The engineering plans for the Lebanon field project on solids separation of primary and secondary suspended solids by mechanical means, have been completed.

PFI and Regional Office representatives met with Duluth Laboratory, Minnesota Board of Health, and Minnesota Medical School representatives for further consideration of the fecal coliform problem related to pulp and paper wastes. Mr. Bauer had earlier correspondence with Dr. Matson of the Minnesota Medical School concerning means to determine the public health significance of *Klebsiella* types isolated from aerated lagoon effluents in the pulp and paper industry. It was agreed that the confirmatory studies completed on stream samples would be carried under PPB 1804 and the Duluth Laboratory would guide the Section V R&D application by the University of Minnesota for funds to complete this work. Both Mr. Bauer and PFI will be given opportunity to review the application.

Some time was devoted to preparation of a report on disposal of bark in Oregon. This was requested by Mr. Klein through Mr. Lacy's office.

Consulting services on pulp and paper waste treatment were provided the Atlanta Regional Office and State of Alaska.

Grant and Contract Research Studies

Research and Demonstration grant administration continued to occupy a significant portion of PFI staff time. Headquarters action on some grant projects paperwork has been slow. A number of projects are nearing

completion. A final draft of the project report by the Oregon State University grant to Professor Burgess of OSU on photographic tracing techniques for Kraft wastes has been submitted. The Beet Sugar Development Foundation at Longmont, Colorado, has completed a final draft which is presently under review. Mead Corporation, Chillicothe, Ohio, has completed all pilot test work and is preparing a first draft of the final report. All R&D projects assigned to PFI in PPB 1204, 1210, and 1301 received a program review during the quarter.

As we are now processing Section V grants in 1204, 1210, and 1301 at PNWL, basic reviews, approvals, and letters for Washington Office action were completed on three Section V grants during the quarter.

Plans for Second Quarter, FY 1971

1. Continue in-house bench scale work on flocculants and polymers with pulp and paper treated waste effluents from nearby aerated lagoons.
2. Start construction and equipment acquisition for the Lebanon field pilot project on solids separation.
3. Continue grant reviews and monitoring.

FOOD WASTES RESEARCH -- PPB 1206

Status of Activities and Significant Accomplishments

Nearly all of the initial printing, 500 copies, of the Proceedings from the First National Food Waste Symposium were distributed. The masters were forwarded to Headquarters for entry into the reports reproduction and distribution system.

Planning has started for a Second Food Waste Research Symposium with tentative dates of March 23-26, 1971 in Denver, Colorado.

The two bench-top, activated sludge pilot plants which were being operated for the National Eutrophication Research Program with and without trisodium nitrilotriacetate (NTA) were stopped at the end of the quarter.

Robert J. Burm presented a paper titled "The Effect of Turbid, High Carbohydrate, Sugar Processing Wastes on Tropical Open Sea" at the Reconvened Session of the 5th International Water Pollution Research Conference in Honolulu.

The pilot plants at the United Flav-R-Pac cannery in Salem, Oregon were started in July. In August the RBC pilot plant was replaced by a larger (1.75 meter discs) and relatively maintenance-free unit. Results thus far from the aerated lagoon containing the tube settler are very encouraging. Influent BOD has ranged from 600 to 1740 mg/l with an average of about 1200. The MLSS of the lagoon has steadily increased to about 2000 mg/l. BOD reduction has ranged from 90 to 96 percent and averaged slightly more than

92 percent. Effluent SS have averaged 56 mg/l and no sludge has been intentionally wasted from the system.

Only limited results have been obtained with the new RBC pilot plant. Based on two sets of data, the BOD has been reduced by 90 percent from an influent of 930 mg/l.

Grant and Contract Research Studies

The following grant proposals and preproposals were reviewed during the quarter:

1. Anaerobic Trickling Filter Treatment of Food Processing Wastes.
2. Strainer Separated Activated Sludge System.
3. Study of Waste Treatment Filter Coverings Under U. S. Patent 3, 176, 845.
4. Biological Treatment of Cucumber Waste.
5. Joint Waste Treatment: City of Holland, Michigan.
6. Anaerobic Treatment of Cannery Wastes.
7. Demonstration of a Process for Economically Converting Seafood Plant Waste to By-Products.
8. Waste Processing Demonstration Plant.

A contract was awarded to Resource Engineering Associates, Division of Environmental Research and Applications, Inc., to develop a State-of-the-Art Study of Water Pollution Control from the Beverage Industry.

Current status of monitored grants is as follows:

1. 12060 EUZ "Winery Wastewater--Characterization and Treatment" Widmer's Wine Cellars, Naples, New York. Bids were resubmitted and the construction contract was awarded. Construction is currently underway with completion scheduled for December 1970.

2. 12060 EKQ "Kent Cheese Company--Waste Treatment Facility" Kent Cheese Company, Melrose Park, Illinois. Additional subsurface aerators were installed in the lagoon to alleviate the anaerobic conditions which occurred because of organic overload. Both lagoons are presently aerobic, operating properly and the post construction studies have begun.

3. 12060 EHS "Cannery Waste Treatment by Lagoons and Oxidation Ditch" Melbourne Water Science Institute, Melbourne, Victoria, Australia. Nothing has been heard from Grantee since the field investigations were terminated last quarter.

4. 12060 EHV "Aerobic Secondary Treatment of Potato Processing Wastes with Mechanical Aeration" The R. T. French Co., Shelley, Idaho. Work is underway on the first draft of the final report.

5. 12060 DSI "State-of-the-Art, Sugarbeet Processing Waste Treatment" Beet Sugar Development Foundation, Fort Collins, Colorado. As yet, the second draft of the final report has not been resubmitted by Grantee.

6. 12060 ECF "Water Pollution Abatement in the United States Seafood Industry: State-of-the-Art" Oregon State University,

Corvallis, Oregon. The Grantee has not yet submitted the final report master for reproduction.

7. 11060 EZR "Complete Aerobic Treatment of Combined Domestic and Industrial Wastes with Mechanical Aeration," City of Dallas, Oregon. Operation of the treatment plant relative to the grant has terminated. Data evaluation for the final report has started.

8. 12060 EIG "Full-Scale Demonstration and Evaluation of Potato Dry and Wet Caustic Peeling Processes," Western Potato Service, Inc., Grand Forks, North Dakota. Evaluation of the "dry-peel" lines was initiated but Grantee still has only two of the three lines installed.

9. WP-01486-01 "Status and Research Needs for Potato Waste Waters," University of Washington, Seattle, Washington. A final audit has not yet been made.

10. 12060 FAD "Pollution Prevention by Aeration of Fruit Processing Wastes," Snokist Growers, Yakima, Washington. The final audit report was received; several questions were raised regarding certain expenditures and these will have to be resolved before the project can be closed out.

11. WPD 93-04-68 "Anaerobic-Aerobic Sugar Beet Waste Treatment" Beet Sugar Development Foundation, Fort Collins, Colorado. No word has been heard from Grantee regarding the final report.

12. 12060 DXL "Reduction of Salt Content of Food Processing Liquid Waste Effluent," National Canners Association, Berkeley, California. The ion exchange pilot plant has been operated with

varying influent levels of COD, SS, salt content, and pH. It is now in continuous operation on olive processing wastes to develop treatment cost figures.

13. 12060 EDK "Production and Disposal Practices for Liquid Wastes from Canning and Freezing Fruits and Vegetables," National Canners Association, Berkeley, California. The first draft of the final report is undergoing major revisions and additions as a result of a brief review.

14. 12060 EHT "Use of Fungi Imperfecti in Waste Control," North Star Research and Development Institute, Minneapolis, Minnesota. An appendix of data is still being put together. It is needed before a final audit can be requested.

15. 12060 EDZ "Pilot Plant Installation for Use of Fungi Imperfecti on Vegetable Wastes," Green Giant Company, LeSueur, Minnesota. Both pilot plants were operated this season on pea and corn wastes. Data collection is finished and work is starting on the final report.

16. 12060 FAK "Concentration of Sugar Beet Wastes for Economic Treatment with Biological Systems," Beet Sugar Development Foundation, Fort Collins, Colorado. The second draft of the final report has been received.

17. 12060 FQE "Dry Caustic Peeling of Tree Fruit to Reduce Liquid Waste Volume and Strength," National Canners Association, Berkeley, California. Work has been completed on peeling of apricots and peaches and is underway on pears. Thus far, the process has

performed very well both in regard to quality of peeled fruit and in reduction of SS and COD in the liquid waste stream.

18. 11060 FJQ "Pollution Abatement and By-Product Recovery in Shellfish and Fisheries Processing--Phase I," City of Kodiak, Alaska. Considerable progress has been made on the protein recovery process and on the collection of data and information needed for site selection as well as waste collection and transportation methods.

19. 12060 FLL "Activated Sludge--Bio-Disc Treatment of Distillery Wastes," American Distilling Company, Pekin, Illinois. A contract has been awarded for the construction and placement of the rotating biological contactor and the general contract is about to be let.

Plans for Second Quarter, FY 1971

1. Continue grant reviewing and monitoring.
2. Continue operation of pilot plants in Salem.

CONSOLIDATED LABORATORY SERVICES PROGRAM

Status of Projects and Significant Accomplishments

General

The NTA-carbon studies were responsible for a workload increase by a factor of three. The increased workload was handled by six temporary employees recruited for this extra effort. The automated analytical systems were used for analysis of NTA, ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, orthophosphate phosphorus, total soluble phosphorus, total phosphorus after persulfate digestion, and soluble silica.

Analytical quality control charts have been developed using a computer program for all constituents that are routinely handled. All data from analytical quality control books in the various laboratories were included in producing background information for producing analytical quality control charts.

A number of changes were made in SHAVES to more effectively handle this increased workload, especially in the clerical area of checking on completion of analysis. Changes were also made in alternatives available in presentation of data in report forms.

The field gas chromatograph for the analysis of CO_2 was completed; it is now undergoing laboratory tests and field tests are being planned.

The Technical Programs conducted a waste water survey of a pulp mill, embarked on a program to gather information from mining operations, and conducted an intensive monitor program for levels of mercury in a

variety of water systems in the region. All of the above resulted in a significant increase in workload. Assistance was also provided in the analysis of a floated sludge to determine the toxicity potential of the material in water. The floated sludge contained significant levels of hydrogen sulfide.

Automated Analytical Systems

The automated system has developed into the workhorse in the production line approach. All six channels were being used almost continuously. Usually, five people were kept busy to prepare samples, read charts, and compute results. The one modification that was made occurred in the NTA-zinc-zincon analysis where a flowthrough resin column replaced an addition of resin to the samples. The resin column reduced the time for sample handling without a noticeable change in precision or recovery.

Specialized Analysis

The Bouveng, H.O. and Davisson, G. procedure for NTA in waste waters was used for the analysis of samples preserved with mercuric chloride and was attempted for analysis of NTA in sea water. Some success was achieved in the use of the procedure. The number of extractions required to complete the analysis precludes it from use as a routine procedure. A flow pattern was set up to determine if the method could be adapted for use in an automated system. Again in this case the judgment was that the time necessary to develop this procedure

in an automated scheme would be excessive. The procedure was relegated to the status "it would be nice if we had the time to run this."

No more work was done on the colorimetric determination of mercury because of the sensitivity and reproducibility of the flameless atomic absorption technique.

The colorimetric determination of arsenic has been refined to permit analysis at lower levels - down to 5 µgms/l.

In the Graduate Fellowship Program, equipment and systems were assembled to measure dissolved nitrogen. A number of runs was made at atmospheric pressure to measure dissolved nitrogen. Work is proceeding satisfactorily in this program.

Atomic Absorption Spectrophotometry

Both atomic absorption spectrophotometers have been used for increased workloads. Tape, wire, rubber bands, and crossed fingers have reduced the level of downtime in the instruments.

Analysis of Carbon

The PNWL carbonaceous analyzer is out of service due to a break-down in infra red detection systems. The total carbon system marketed by Oceanography International has been shipped and will be tested by CLS. No word has been heard from the Beckman Company on the contract that was awarded to them for modification of the carbonaceous analyzer.

Biology and Microbiology

The biological section continues to offer service to the Technical Programs based in Portland and to NTA studies. The microbiological section was mainly involved in the NTA-carbon studies.

A meeting was held at the invitation of Dr. Warren Westgarth on the chemical analysis of mercury in water samples. The meeting brought together interested parties in the area who are performing or interested in performing analysis for mercury in water, waste water, and allied materials. The meeting produced a forum for an excellent exchange of ideas.

Areas of Concern

Some time will have to be allocated for a complete check of electronics in a variety of instruments to insure that breakdown will not occur. A program of preventive maintenance will be initiated.

Reports and Papers

"Tracing Oil as a Pollutant in Water" was prepared by Nick J. Malueg and Daniel F. Krawczyk for presentation at the Evangeline Regional Meeting of the Petroleum Engineers in Lafayette, Louisiana on November 9-10, 1970.

"Research Needs from the Viewpoint of the Federal Program, Northwest Region - Analytical Methodology" was prepared by Daniel F. Krawczyk for presentation at the PNPCA annual meeting to be held at Victoria, British Columbia, Canada on October 23, 1970.

Plans for Second Quarter, FY 1971

Update all AQC charts for the NTA report. Complete all work on NTA studies. Provide assistance in producing data for the NTA report. Concentrate on reducing the backlog. Prepare specification for computer interface between the technician, autoanalyzer, and computer to eliminate manual reading of charts.

TRAINING AND MANPOWER DEVELOPMENT

Status of Projects and Significant Accomplishments

Direct Training

The following courses were presented during the quarter:

Water Quality Surveys, July 20-24, Corvallis - 26 students.

Marine Pollution Ecology Seminar, July 29-31, Juneau, Alaska - 45 students;

Marine Pollution Ecology Seminar, August 4-6, Anchorage - 22 students.

Freshwater Biology and Pollution Ecology, September 14-25, Corvallis - 25 students.

Membrane Filter Techniques Workshop, September 2-3, Boise, Idaho - 14 students.

Manpower Development

CAMPS meetings were attended in Oregon, Washington, and Idaho.

The City of Portland has applied for National Contract funds to continue on-job training of sewage treatment plant operators.

A staff member is meeting with Oregon Apprenticeship personnel in development of sewage treatment plant operator training under the apprenticeship program.

A staff member is a member of the Oregon Board of Education Environmental Services Career Education Advisory Committee. The Committee will assist in the evaluation of manpower programs in the environmental field.

Public Relations

Tours and orientation were provided for 125 people. Films and slide/tapes were loaned for viewing by 850 people. Over 800 publications were distributed.

Plans for the Second Quarter, FY 1971

Sewage Treatment Facilities for Federal Installations, October 26-30, Corvallis. Due to heavy advance enrollment in the October course offering, an additional presentation has been scheduled for November 2-6, 1970.